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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Gordon F. Grigor, Vladimir Giemborek, and John Faberfeller
Docket No: 0100.01117
Title: Method and Apparatus for Configuring Multiple Displays Associated with a Computing System

To the Honorable Commissioner
of Patents and Trademarks
Box Patent Application
Washington, D.C. 20231

Date:

TRANSMITTAL LETTER FOR FILING A NATIONAL PATENT APPLICATION

The applicants hereby respectfully request that the above captioned patent application be accepted for examination. This patent application is a:

☒ new patent application;
☐ continuation in part (CIP) of Application Serial No. filed on ;
☐ divisional application of Application Serial No. filed on ;
☐ continuation of Application Serial No. filed on ;

Accompanying this request is (as indicated by an "X" in the corresponding box):

☒ 1. 25 pages of specification, which includes the claims and abstract, and 4 sheets of formal drawings;

☐ 2. Combined Declaration and Power of Attorney;

☐ 3. An Information Disclosure Statement along with the references;

☐ 4. A petition to extend the response for a priority application identified above;

☐ 5. An assignment assigning all rights in the above referenced patent application to ;

☐ 6. An assignment recording cover sheet;

☐ 7. A verified statement establishing small entity status under 37 C.F.R. Sections 1.9 and 1.27;

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Respectfully submitted,

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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Gordon F. Grigor et. al. Examiner:
Serial No: Art Group:
Filing Date: Docket No: 0100.01117
Title: Method and Appratus for Configuring Multiple Displays Associated With a Computing System

To the Honorable Commissioner
of Patents and Trademarks
Washington, D.C. 20231

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Method and Apparatus for Configuring Multiple Displays Associated with a Computing System

Technical Field of the Invention

The present invention relates generally to computers and their associated displays and more particularly to multiple displays associated with a computer.

Background of the Invention

Computers are known to include a central processing unit, system memory, video graphics circuitry, audio processing circuitry, and peripheral ports. The peripheral ports provide connectivity between the computer and peripheral devices, such as printers, displays, tape drives, and other external memory devices. As is known, displays provide computer users with a visual representation of computer applications (e.g., word processing, drawing, games, TV tuner, etc.) that are being executed by the computer. As the computer executes the computer applications, the central processing unit provides processed data to the video graphics circuitry.

The video graphics circuitry receives the processed data, converts it into display ready data, and provides the display ready data to the display at the appropriate time and rate. For example, if the computer is processing a word processing application and the display is a CRT display having a refresh rate of sixty, the video graphics circuitry converts the processed data into RGB (Red, Green, Blue) pixel data, which may be 8, 16, or 32 bits/pixel, and stores it in a frame buffer, or screen memory. The video graphics

circuitry retrieves the stored RGB pixel data from the frame buffer and provides it to the CRT display at the refresh rate.

In the above-described example, the video graphics circuitry is coupled to one display device, which is typical in most computer applications. As such, the video graphics circuitry is dedicated to a single display device. Many computers, however, include an additional monitor port such that two displays may be driven from a single video graphics card. While this allows two displays to be driven from a single video graphics card, both displays will display the same image. In addition, both displays must have the same refresh rate and resolution (e.g., 640 by 480 pixel screen size). If a computer user desires that the two displays display different images, the computer needs to include two video graphics cards

While the two separate video graphics cards allow for two displays to display different images, the video graphics cards are essentially dedicated to their respective displays. In other words, each video graphics card is hard wired to a display port, which couples to one of the two displays. Thus, to change which video graphics card is driving which display, the physical connection or motherboard location of the video graphics card would need to be changed. If the displays are substantially the same, dedicated coupling to one video graphics card or the other does not affect the quality of the images being displayed. If, however, the displays are not the same (e.g., one is an LCD display and the other is a CRT monitor), image quality may vary. Thus, it would be desirable to provide images requiring a higher quality to the display capable of providing the desired quality and to provide images requiring less quality to the display having a lower quality. If the computer user knows which images require higher quality, the user can insure that the images will be processed by the appropriate video graphics card and thus displayed on the desired display. If not, the images may be displayed on the display having the lower quality.

Therefore, a need exists for a method and apparatus that provides for multiple displays to be coupled to a computer without requiring the computer to include a dedicated video graphics card for each display and provides programmable con.

Brief Description of the Drawings

Figure 1 illustrates a schematic block diagram of a computing system in accordance with the present invention;

Figure 2 illustrates a schematic block diagram of a video graphics processing circuit of the computing system of Figure 1;

Figure 3 illustrates a schematic block diagram of an alternate video graphics processing circuit of the computing system of Figure 1; and

Figure 4 illustrates a logic diagram of a method for configuring multiple displays associated with a computing system in accordance with the present invention.

Detailed Description of a Preferred Embodiment

Generally, the present invention provides a method and apparatus for configuring multiple displays associated with a computing system. The configuring begins when display preferences regarding at least one of the multiple displays are received. The display preferences indicate desired selections of which images are to be displayed on which displays and may be based on user selections or application selections. Having received the display preferences, a coupling controller within a video graphics processing circuit determines whether the display preferences can be fulfilled in observance of configuration properties. The configuration properties include limitations of the displays (e.g., refresh rate, resolution) and the computing system (e.g., display controller capabilities) and/or rules of the computing system (e.g., at least one screen must be actively coupled at all times). If the display preferences can be fulfilled, the coupling

controller causes display controllers to be operably coupled to displays. If, however, the display preferences cannot be fulfilled, the coupling controller determines whether the current configuration can be reconfigured to allow the display preferences to be fulfilled with minimal affect on the perceived current configuration. If so, the coupling controller causes the video graphics processing circuitry to be reconfigured. With such a method and apparatus, a single video graphics card can be used to drive multiple displays. In addition, the present invention provides a dynamic coupling of displays to display controllers such that image quality can be optimized, user preferences can be accommodated, and application preferences can be accommodated.

The present invention can be more fully described with reference to Figures 1 through 4. Figure 1 illustrates a schematic block diagram of a computing system 10 that includes a video graphics processing circuit 12, a central processing unit (CPU) 14, a video source 15, a user interface 16, multiple displays 18 – 22, and a plurality of applications 24. The CPU 14 may be any central processing unit of a personal computer, laptop computer, workstation, personal digital assistant, or any computing device. The user interface 15 may be a graphical user interface, a touch screen, a keyboard, or any other means for providing user inputs to the computing system 10. The video source 15 may be a television tuner, video cassette player or recorder, DVD player, satellite receiver, or cable box. The displays 18 – 22 may be CRT monitors, televisions, LCD panel displays, or any combination thereof. The applications 24 may be any application that the CPU, and/or a co-processor (not shown), may execute. For example, the applications 24 may be, but not limited to, word processing applications, Internet access applications, drawing applications, presentation applications, scheduling applications, video source applications, and specialty applications (e.g., typing instruction applications, legal forms applications, etc.).

The video graphics processing circuit 12 includes a coupling controller 26, a coupling module 28, memory 30, and a plurality of display controllers 32 – 36. The coupling controller 26 may be a software module that receives display preferences 40 from the user interface 16 and/or the CPU 14. The display preferences 40 include

preferences as to how the user and/or a specific application running on the CPU 14 would like images from various sources to be displayed on which display 32 – 36. The display preferences 40 include: (i) displaying an image (i.e., the same image) on more than one of the multiple displays; (ii) displaying separate images on each of the multiple displays (e.g., a video image from a television tuner on one display and an application running on the CPU 14 on another display); (iii) displaying a portion of the image on one of the multiple displays and displaying the image on another one of the multiple displays (e.g., having one display supporting a full screen of a drawing applications and the other display supporting the toolbars); iv) providing different refresh rates for at least two of the multiple displays; v) providing different resolutions for at least two of the multiple displays; vi) selecting a particular one of the multiple displays to display a particular type of image (e.g., have the television display images from the video source 15, having the CRT display supporting applications requiring high resolution, and an LCD display supporting applications requiring less resolution); and vii) displaying a first portion of the image on a first one of the multiple displays and displaying a second portion of the image on a second one of the multiple displays (e.g., page one of a document on one display and page two of the document on another display).

Upon receiving the display preferences 40, the coupling controller 26 determines whether the display preferences 40 can be fulfilled in observance of configuration properties 48. The configuration properties 48 include properties of the multiple displays and properties of the computing system 10. The configuration properties 48 of a display include limitations of the display such as refresh rate, resolution, type of display (e.g., television ,CRT display, LCD display), etc. The configuration properties 48 of the computing system relate to the capabilities of the display controllers 32 – 36. For example, the configuration properties include one display controller supports a television, another display controller supports a dual scan LCD display, yet another display controller supports lower refresh rate and/or resolution CRT displays, and still another display controller supports high resolution and/or high refresh rate displays. The operational rules of the computing system include rules established by the computing system manufacturer that insure a certain level of performance. For example, the rules

may include a stipulation that at least one display needs to be active at any given time and/or a stipulation that a certain one of the display controllers cannot be coupled to a particular display.

If the display preferences can be fulfilled, the coupling controller provides configuration requirements 27 to the coupling module 28. The coupling module 28 effectively closes "switches" such that the desired display controller 32 – 36 is coupled to one or more of the displays 18 – 22. In addition, the coupling module closes one or more "switches" such that one or more of the display controllers 32 – 36 is coupled to retrieve display data from the screen memory 38. For example, if the same image is to be identically displayed on displays 18 and 20 and display controller 32 is to support them, the top "switch" associated with an output of the screen memory 38 is closed and the top two "switches" associated with the output of display controller 32 are closed.

As another example, assume that the same image is to be displayed on different displays 18 and 20, but are to be under separate control such that they may be presented in a different manner (e.g., at a different resolution, one display is displaying a portion of the image while the other screen is displaying the whole image, or one display is displaying a first portion of an image and the other is displaying a second portion of the image). In this example, two of the "switches" associated with the output of the screen memory 38 are closed, coupling the input of display controllers 32 and 34 to the screen memory 38. The top "switch" associated with the output of display controller 32 is closed to couple display controller 32 to display 18. Also, the top "switch" associated with the output of display controller 34 is closed coupling display controller 34 to display 20. As one of average skill in the art will appreciate, the display controllers 32 – 36, the screen memory 38, and the displays 18 – 22 may be coupled in any of a plurality of configurations.

If the display preferences cannot be fulfilled, the coupling controller 26 determines whether the current configuration can be reconfigured to fulfill the display preferences and to maintain the effective current configuration. For example, if display

18 is a high resolution display and is currently coupled to display controller 32 and the display preferences desires to have display controller support display 20, the coupling controller 26 will determine whether one of the other display controllers is capable of supporting display 18. If so, the coupling controller 26 reconfigures the computing system, in particular, the video graphics processing circuit 12 such that display controller 32 is supporting display 20 and one of the other display controllers 34 or 36 is supporting display 18. To the computer user, the reconfiguration is made with minimal, or no, adverse visual affects to the images being displayed. If, however, the display preferences cannot be fulfilled, the coupling controller 26 provides an error, or denial, message.

The video graphics processing circuit 12 has thus far been primarily discussed in terms of its function. The physical implementation of the video graphics processing circuit 12 is equally as flexible. For example, the display controllers 32 – 36 may be included in a single adapter, or graphics chip, or each display controller 32 – 36 may be included on a separate graphics chip. Regardless of how the display controllers 32 – 36 are packaged, they are included on a single video graphics card. In general, the display controllers 32 – 36 retrieve display data from the screen memory 38 and provide it to the appropriate display 18 – 22. The display controllers 32 – 36 are similar to those used in the All-In-Wonder video product manufactured and distributed by ATI Technologies, Inc.

The memory 30 may be random access memory, cache memory, floppy disk memory, hard disk memory, DVD memory, magnetic tape memory, and/or any other means for storing digital information. In addition, the memory 30 may be memory on the video graphics processing circuit 12, system memory of the computing system, and/or any memory that can be coupled to the computing system and accessed by the video graphics processing circuit 12. The screen memory 38, as previously mentioned, stored display data. The type of display data varies depending on the capabilities of the displays 18 – 22. For example, the display data for a CRT display is RGB pixel data that may be 8, 16, or 32 bits/pixel. The display data for a television is YUV or Y,Cr,Cb data. The

display data for an LCD display is 3 bit/pixel RGB pixel data that is stored in a dual scan mode.

The coupling module 28 is shown to include a plurality of "switches". If the coupling module 28 is implemented in hardware, the "switches" will be physical switches, or the like, to provide the connectivity between the screen memory 38, the display controllers 32 – 36, and the displays 18 – 22. If, however, the coupling module 28 is implemented in software, the "switches" are implemented as registers that indicate the connectivity between the screen memory 38, the display controllers 32 – 36, and the displays 18 – 22. As one of average skill in the art will appreciate, the coupling module 28 may be further implemented as a combination of software and hardware.

Figure 2 illustrates a schematic block diagram of the video graphics processing circuit 12 that includes the coupling controller 26, the coupling module 28, the memory 30, the display controllers 32 – 36, a plurality of display drivers 52 – 56, and a graphics engine 56. The memory 30 includes a plurality of screen memory sections 38, 42, 44 and configuration memory 46, which stores the configuration properties 56. As such, one screen memory section may store display data for a television, another screen memory may store display data for a CRT display, and yet another screen memory may stored display data for an LCD display. Alternatively, the screen memory sections may be storing display data of the same image, but with different RGB data (i.e., 8, 16, or 32 bit/pixel). As another alternative, the screen memory sections may be storing different windows, etc. As one of average skill in the art, the screen memory sections may store display data in any number of combinations.

The display drivers 50 – 54 and the graphics engine 56 function in a similar manner to similar devices in the All-In-Wonder video graphics product manufactured and distributed by ATI Technologies, Inc. In general, the display drivers 50 – 54 write the display data into coupled screen memories 38, 42, 44 in association with the graphics engine 56.

As shown, the coupling module 28 includes a plurality of "switches" that provides numerous configuration possibilities. The output of each element (i.e., the display controllers, the screen memories, and the display drivers) is coupled to three "switches". This allows the output of an element to supply data to one, two, or all three of the receiving elements (i.e., the displays, the display controllers, and the screen memories). For example, the display drivers 50 – 54 may be configured such that one display driver writes the display data to all three of the screen memories, that one display driver writes to two screen memories and another writes to the third screen memory, that each of the display drivers writes to a separate screen memory, or that a display driver writes to only one or two of the screen memories (i.e., not all of the screen memories are used). The options for coupling the display controllers 32 – 36 to the displays 18 – 22 and coupling the screen memories 38, 42, 44 to the display controllers 32 – 36 are equally as numerous. As one of average skill in the art will appreciate, the number of display drivers, display controllers, and screen memories can vary from the three shown, which was selected for illustration purposes only, and that the number of display controllers, display drivers, and screen memories do not have to match.

Figure 3 illustrates a schematic block diagram of an alternate video graphics processing circuit 60 that includes a processing unit 62 and memory 64. The processing unit 62 may be a microprocessor, microcontroller, microcomputer, digital signal processor, central processing unit, and/or any device(s) that manipulates digital information based on programming instructions. The memory 64 may be read only memory, random access memory, floppy disk memory, hard disk memory, magnetic tap memory, DVD memory, CD memory, and/or any means for storing digital information.

The memory 64 stores programming instructions that, when executed by the processing unit 62, cause the processing unit 62 to function as a plurality of circuits 66 – 70. While executing the programming instructions, the processing unit functions as circuit 66 that receives display preferences regarding at least one display. The processing unit 62 then functions as circuit 68 that determines whether the display preferences can be fulfilled in observance of configuration properties. If so, the processing unit 62

functions as circuit 70 that configures the computing system an the at least one display in accordance with the display preferences. The programming instructions stored in memory 64, which may be a separate memory device, and the execution thereof by the processing unit 62 will be discussed in greater detail with reference to Figure 4.

Figure 4 illustrates a logic diagram of a method for configuring multiple displays associated with a computing system. The process begins at step 80 where display preferences are received regarding at least one of the multiple displays. The display preferences may be received from a user via a user interface or from an application via the CPU. In either case, the display preferences provide an image-to-display selection, or selections, such that a particular one of the displays is selected to display a particular image. The process then proceeds to step 82 where a determination is made as to whether the display preferences can be fulfilled in observance with configuration properties of the selected display(s) and/or of the computing system. The configuration properties of the display(s) relate to limitations of the display(s), while configuration properties of the computing system relate to the capabilities of the display controllers and to computing system rules. As previously mentioned, the display controllers may be designed to support a television, an LCD display, a low resolution and/or refresh rate CRT display, a high resolution and/or refresh rate CRT display, and/or to support 8, 16, or 32 bit/pixel display data.

The process then proceeds to step 84 where the answer to step 82 is obtained. If the display preferences can be fulfilled, the process proceeds to step 86 where the computing system and the display(s) is configured in accordance with the display preferences. The configuration may be done in any number of ways. For example, the configuring of the computing system and the display(s) includes operably coupling a display controller of the computing system to the display(s); includes operably coupling the display controller to at least one of the screen memories; includes operably coupling the display controller to at least one of a plurality of display drivers; includes operably coupling a first display controller of the computing system to a first display and operably coupling a second

display controller of the computing system to a second display; and/or operably coupling the first display controller to a third display.

If, however, the display preferences cannot be fulfilled, the process proceeds to step 88 where a determination is made as to whether the current configuration can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration. The process then proceeds to step 90 where the answer to step 88 is obtained. If the current configuration can be reconfigured, the process proceeds to step 92 where the computing system and the display(s) are reconfigured. If, however, the current configuration is not reconfigurable, the process proceeds to step 91 where a denial message is provided.

After the computing system and the displays have been configured or reconfigured, the process proceeds to step 94 where a determination is made as to whether tow display controllers are coupled to the same screen memory. If so, the process proceeds to step 96 where the flipping of the screen memory waits until both of the display controllers have finished reading the current frame. The process proceeds to step 98 where a determination is made as to whether new display preferences have been received. If so, the process repeats beginning at step 82. If not, the process processes the present configuration until new display preferences are received.

The preceding discussion has presented a method and apparatus for configuring multiple displays associated with a computing system. With the present invention, the multiple displays may be dynamically configured to display the same images, different images, portions of the same image, the same images with different display properties, and/or a combination thereof. The present invention provides this dynamic configurability from a single video graphics card that includes one or more graphics chips, where each graphics chip includes one or more display controllers. It should be understood that the implementation of other variations and modifications of the invention in its various aspects will be apparent to those of ordinary skill in the art, and that the invention is not limited by the specific embodiments described. Further, any such

modifications, variations, or equivalents fall within the spirit and scope of the basic underlying principles disclosed and claimed herein.

Claims

What is claimed is:

1. A method for configuring multiple displays associated with a computing system, the method comprises the steps of:

a) receiving display preferences regarding at least one of the multiple displays;

b) determining whether the display preferences can be fulfilled in observance of at least one of: configuration properties of the at least one of the multiple displays and configuration properties of the computing system; and

c) when the display preferences can be fulfilled, configuring the computing system and the at least one of the multiple displays in accordance with the display preferences.

2. The method of claim 1 further comprises receiving the display preferences from at least one of: a user interface of the computing system and an application running on the computing system.

3. The method of claim 1, wherein the display preferences include at least one of:

i) displaying an image on more than one of the multiple displays;

ii) displaying separate images on each of the multiple displays;

iii) displaying a portion of the image on one of the multiple displays and displaying the image on another one of the multiple displays;

iv) providing different refresh rates for at least two of the multiple displays;

v) providing different resolutions for at least two of the multiple displays;

vi) selecting a particular one of the multiple displays to display a particular type of image; and

vii) displaying a first portion of the image on a first one of the multiple displays and displaying a second portion of the image on a second one of the multiple displays.

4. The method of claim 1, wherein the configuration properties of the at least one of the multiple displays includes at least one of: limitations of the at least one of the multiple displays, and wherein the configuration properties of the computing system includes at least one of: limitations of the computing system and operational rules of the computing system.

5. The method of claim 1 further comprises:

when the display preferences cannot be fulfilled, determining whether a current configuration of the multiple displays to the computing system can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration; and

when the current configuration can be reconfigured, reconfiguring operable coupling of the multiple displays to the computing system such that the at least one of the multiple displays is configured in accordance with the display preferences.

6. The method of claim 1 further comprises providing an denial message when the display preferences cannot be fulfilled.

7. The method of claim 1, wherein step (c) further comprises operably coupling a display controller of the computing system to the at least one of the multiple displays, wherein the display controller provides display data to the at least one of the multiple displays.

8. The method of claim 7, wherein step (c) further comprises operably coupling the display controller to at least one of a plurality of screen memories, wherein each of the

plurality of the screen memories stores separate display data and wherein the display controller retrieves the display data from the at least one of the plurality of screen memories.

9. The method of claim 8, wherein step (c) further comprises operably coupling the display controller to at least one of a plurality of display drivers, wherein each of the plurality of display drivers writes the separate display data to the plurality of screen memories.

10. The method of claim 1, wherein step (c) further comprises operably coupling a first display controller of the computing system to a first display of the at least one of the multiple displays and operably coupling a second display controller of the computing system to a second display of the least one of the multiple displays.

11. The method of claim 10 further comprises operably coupling the first display controller to a third display of the at least one of the multiple displays.

12. The method of claim 1, wherein step (c) further comprises operably coupling a first display controller of the computing system to a first display of the at least one of the multiple displays, operably coupling a second display controller of the computing system to a second display of the at least one of the multiple displays, and operably coupling the first and second display controllers to a screen memory.

13. The method of claim 1 further comprises operably coupling at least two of the multiple displays to one of a plurality of screen memories.

14. A video graphics processing circuit comprises:

a plurality of display controllers;

memory, wherein at least a portion of the memory is screen memory;

coupling module operably coupled to the plurality of displays and the screen memory; and

a coupling controller operably coupled to receive display preferences and to determine whether the display preferences can be fulfilled in observance of configuration properties, wherein, when the display preferences can be fulfilled, the coupling controller provides configuration requirements to the coupling module, wherein the coupling module, based on the configuration requirements, operably couples at least one of the plurality of display controllers with at least a portion of the screen memory and with at least one display, and wherein the at least one of the plurality of display controllers retrieves display data from the at least a portion of the screen memory and provides the display data to the at least one display.

15. The video graphics processing circuit of claim 14, wherein the screen memory comprises a plurality of screen memory portions, wherein each of the plurality of screen memory portions stores separate display data.

16. The video graphics processing circuit of claim 15 further comprises a plurality of display drivers, wherein, when coupled via the coupling module to one of the plurality of screen memory portions, a display driver of the plurality of display drivers writes the separate display data to the one of the plurality of screen memory portions.

17. The video graphics processing circuit of claim 16 further comprises a graphics engine operably coupled, via the coupling module, to at least one of the plurality of display controllers and at least one of the display drivers.

18. The video graphics processing circuit of claim 14 further comprises a user interface that is operably coupled to the coupling controller and to receive the display preferences from a user.

19. The video graphics processing circuit of claim 14, wherein the memory further comprises properties memory that stores configuration properties of the plurality of display controllers and the at least one display, wherein the configuration properties include at least one of: limitations of the plurality of display controllers and the at least one display and operational rules of the plurality of display controllers and the at least one display.

20. The video graphics processing circuit of claim 14, wherein the coupling controller provides reconfiguration requirements to the coupling module when the display preferences cannot be fulfilled but a current configuration of the plurality of display controllers to the at least one display can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration.

21. The video graphics processing circuit of claim 14, wherein the configuration requirements cause the coupling module to operably coupling a first display controller of the plurality of display controllers to a first display of the at least one display and operably coupling a second display controller of the plurality of display controllers to a second display of the least one display.

22. The video graphics processing circuit of claim 21, wherein the configuration requirements cause the coupling module to operably coupling the first display controller to a third display of the at least one display.

23. The video graphics processing circuit of claim 14, wherein the configuration requirements cause the coupling module to operably coupling a first display controller of

the plurality of display controllers to a first display of the at least one display, operably coupling a second display controller of the plurality of display controllers to a second display of the at least one display, and operably coupling the first and second display controllers to the screen memory.

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24. A video graphics processing circuit comprises:

a processing unit; and

memory operably coupled to the processing unit, wherein the memory stores programming instructions that, when executed by the processing unit, cause the processing unit to (a) receive display preferences regarding at least one of a multiple displays; (b) determine whether the display preferences can be fulfilled in observance of at least one of: configuration properties of the at least one of the multiple displays and configuration properties of a computing system; and (c) configure the computing system and the at least one of the multiple displays in accordance with the display preferences when the display preferences can be fulfilled.

25. The video graphics processing circuit of claim 24, wherein the memory further comprises programming instructions that cause the processing unit to:

determine whether a current configuration of the multiple displays to the computing system can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration when the display preferences cannot be fulfilled; and

reconfigure operable coupling of the multiple displays to the computing system such that the at least one of the multiple displays is configured in accordance with the display preferences when the current configuration can be reconfigured.

26. The video graphics processing circuit of claim 24, wherein the memory further comprises programming instructions that cause the processing unit to operably couple a display controller of the computing system to the at least one of the multiple displays, wherein the display controller provides display data to the at least one of the multiple displays.

27. The video graphics processing circuit of claim 26, wherein the memory further comprises programming instructions that cause the processing unit to operably couple the display controller to at least one of a plurality of screen memories, wherein each of the plurality of the screen memories stores separate display data and wherein the display controller retrieves the display data from the at least one of the plurality of screen memories.

28. The video graphics processing circuit of claim 27, wherein the memory further comprises programming instructions that cause the processing unit to operably couple the display controller to at least one of a plurality of display drivers, wherein each of the plurality of display drivers writes the separate display data to the plurality of screen memories.

29. The video graphics processing circuit of claim 24, wherein the memory further comprises programming instructions that cause the processing unit to operably couple a first display controller of the computing system to a first display of the at least one of the multiple displays and operably coupling a second display controller of the computing system to a second display of the least one of the multiple displays.

30. The video graphics processing circuit of claim 29, wherein the memory further comprises programming instructions that cause the processing unit to operably couple the first display controller to a third display of the at least one of the multiple displays.

31. The video graphics processing circuit of claim 24, wherein the memory further comprises programming instructions that cause the processing unit to operably couple a first display controller of the computing system to a first display of the at least one of the multiple displays, operably coupling a second display controller of the computing system to a second display of the at least one of the multiple displays, and operably coupling the first and second display controllers to a screen memory.

32. The video graphics processing circuit of claim 31, wherein the memory further comprises programming instructions that cause the processing unit to operably couple at least two of the multiple displays to one of a plurality of screen memories.

33. A digital storage medium for storing programming instructions that, when executed by a processing unit, cause the processing unit to configure multiple displays associated with a computing system, the digital storage medium comprises:

first means for storing programming instructions that cause the processing unit to receive display preferences regarding at least one of the multiple displays;

second means for storing programming instructions that cause the processing unit to determine whether the display preferences can be fulfilled in observance of at least one of: configuration properties of the at least one of the multiple displays and configuration properties of the computing system; and

third means for storing programming instructions that cause the processing unit to configure the computing system and the at least one of the multiple displays in accordance with the display preferences when the display preferences can be fulfilled.

34. The digital storage medium of claim 33 further comprises means for storing programming instructions that cause the processing unit to:

determine whether a current configuration of the multiple displays to the computing system can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration when the display preferences cannot be fulfilled; and

reconfigure operable coupling of the multiple displays to the computing system such that the at least one of the multiple displays is configured in accordance with the display preferences when the current configuration can be reconfigured.

35. The digital storage medium of claim 33 further comprises means for storing programming instructions that cause the processing unit to operably couple a display

controller of the computing system to the at least one of the multiple displays, wherein the display controller provides display data to the at least one of the multiple displays.

36. The digital storage medium of claim 35 further comprises means for storing programming instructions that cause the processing unit to operably couple the display controller to at least one of a plurality of screen memories, wherein each of the plurality of the screen memories stores separate display data and wherein the display controller retrieves the display data from the at least one of the plurality of screen memories.

37. The digital storage medium of claim 33 further comprises means for storing programming instructions that cause the processing unit to operably couple the display controller to at least one of a plurality of display drivers, wherein each of the plurality of display drivers writes the separate display data to the plurality of screen memories.

38. The digital storage medium of claim 33 further comprises means for storing programming instructions that cause the processing unit to operably couple a first display controller of the computing system to a first display of the at least one of the multiple displays and operably coupling a second display controller of the computing system to a second display of the least one of the multiple displays.

39. The digital storage medium of claim 38 further comprises means for storing programming instructions that cause the processing unit to operably couple the first display controller to a third display of the at least one of the multiple displays.

40. The digital storage medium of claim 33 further comprises means for storing programming instructions that cause the processing unit to operably couple a first display controller of the computing system to a first display of the at least one of the multiple displays, operably coupling a second display controller of the computing system to a second display of the at least one of the multiple displays, and operably coupling the first and second display controllers to a screen memory.

41. The digital storage medium of claim 40 further comprises means for storing programming instructions that cause the processing unit to operably couple at least two of the multiple displays to one of a plurality of screen memories.

Docket No. 50R9535.01

Method and Apparatus for Configuring Multiple Displays Associated with a Computing System

Abstract of the Disclosure

A method and apparatus for configuring multiple displays associated with a computing system begins when display preferences regarding at least one of the multiple displays are received. The display preferences indicate desired selections of which images are to be displayed on which displays and may be based on user selections or application selections. Having received the display preferences, a coupling controller within a video graphics processing circuit determines whether the display preferences can be fulfilled in observance of configuration properties. The configuration properties include limitations of the displays (e.g., refresh rate, resolution) and the computing system (e.g., display controller capabilities) and/or rules of the computing system (e.g., at least one screen must be actively coupled at all times). If the display preferences can be fulfilled, the coupling controller causes display controllers to be operably coupled to displays. If, however, the display preferences cannot be fulfilled, the coupling controller determines whether the current configuration can be reconfigured to allow the display preferences to be fulfilled with minimal affect on the perceived current configuration. If so, the coupling controller causes the video graphics processing circuitry to be reconfigured.

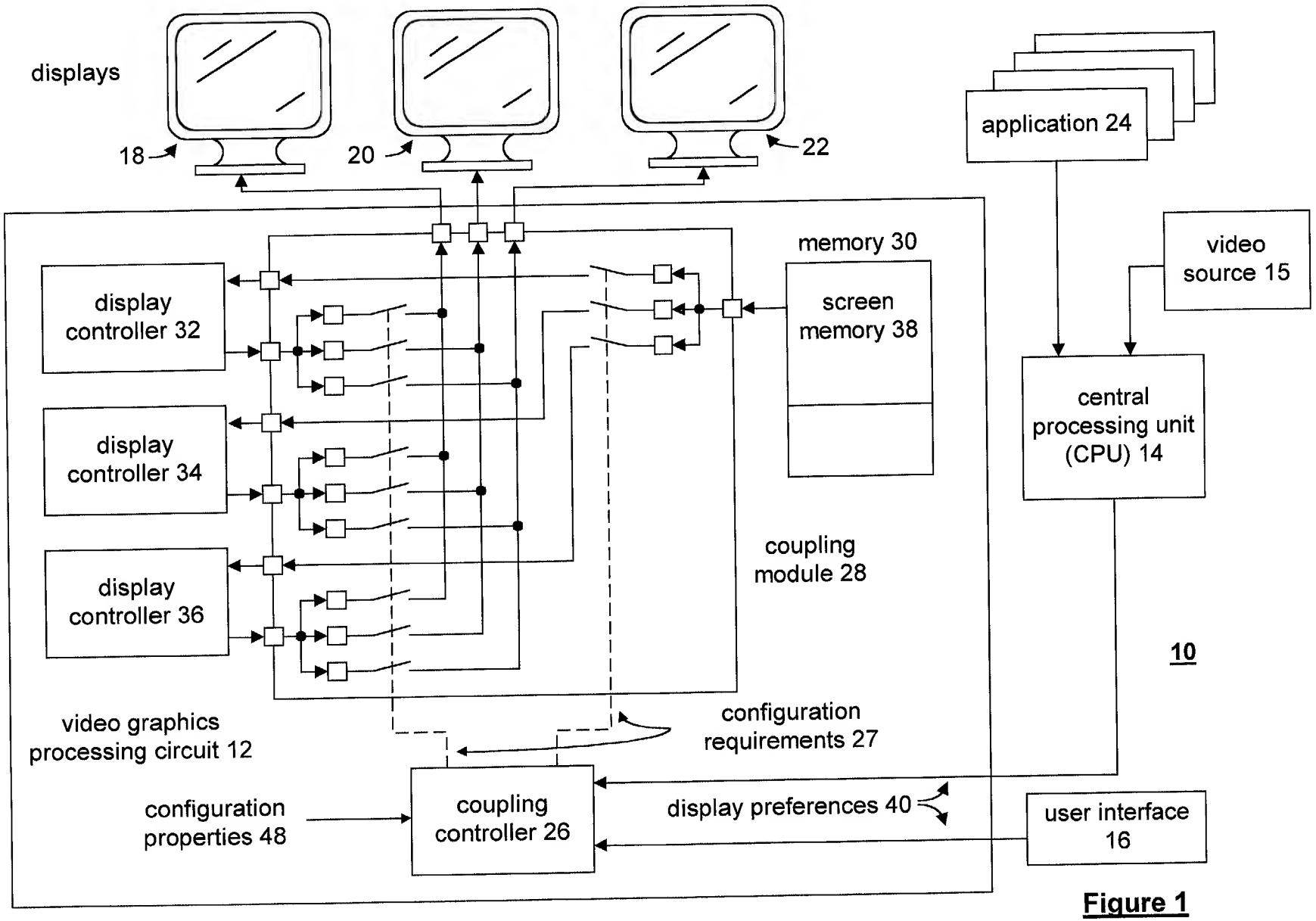

Figure 1

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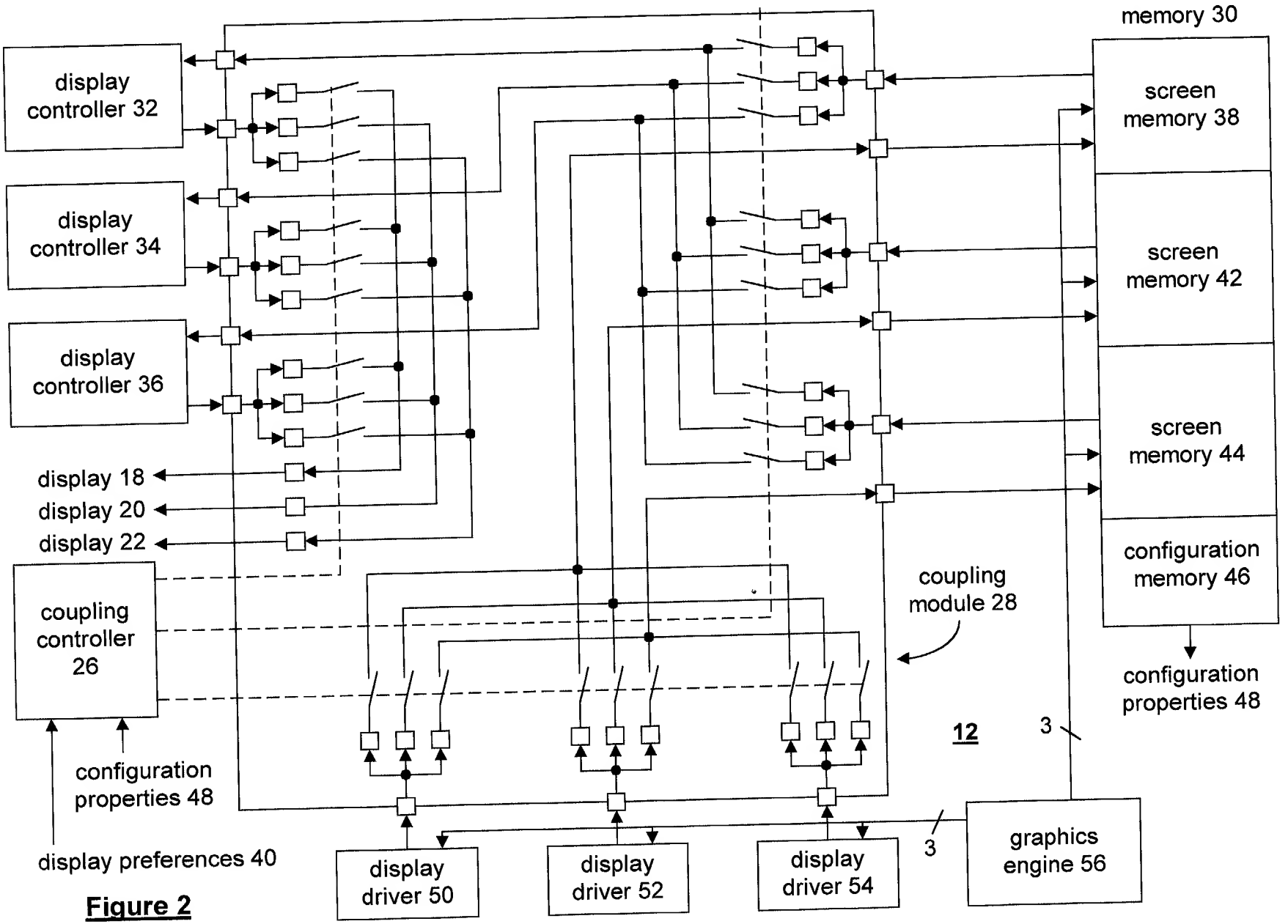

memory 30
display controller 32
display controller 34
display controller 36
screen memory 38
screen memory 42
screen memory 44
configuration memory 46
configuration properties 48
display 18
display 20
display 22
coupling controller 26
coupling module 28
12
3
configuration properties 48
display preferences 40
display driver 50
display driver 52
display driver 54
3
graphics engine 56

Figure 2

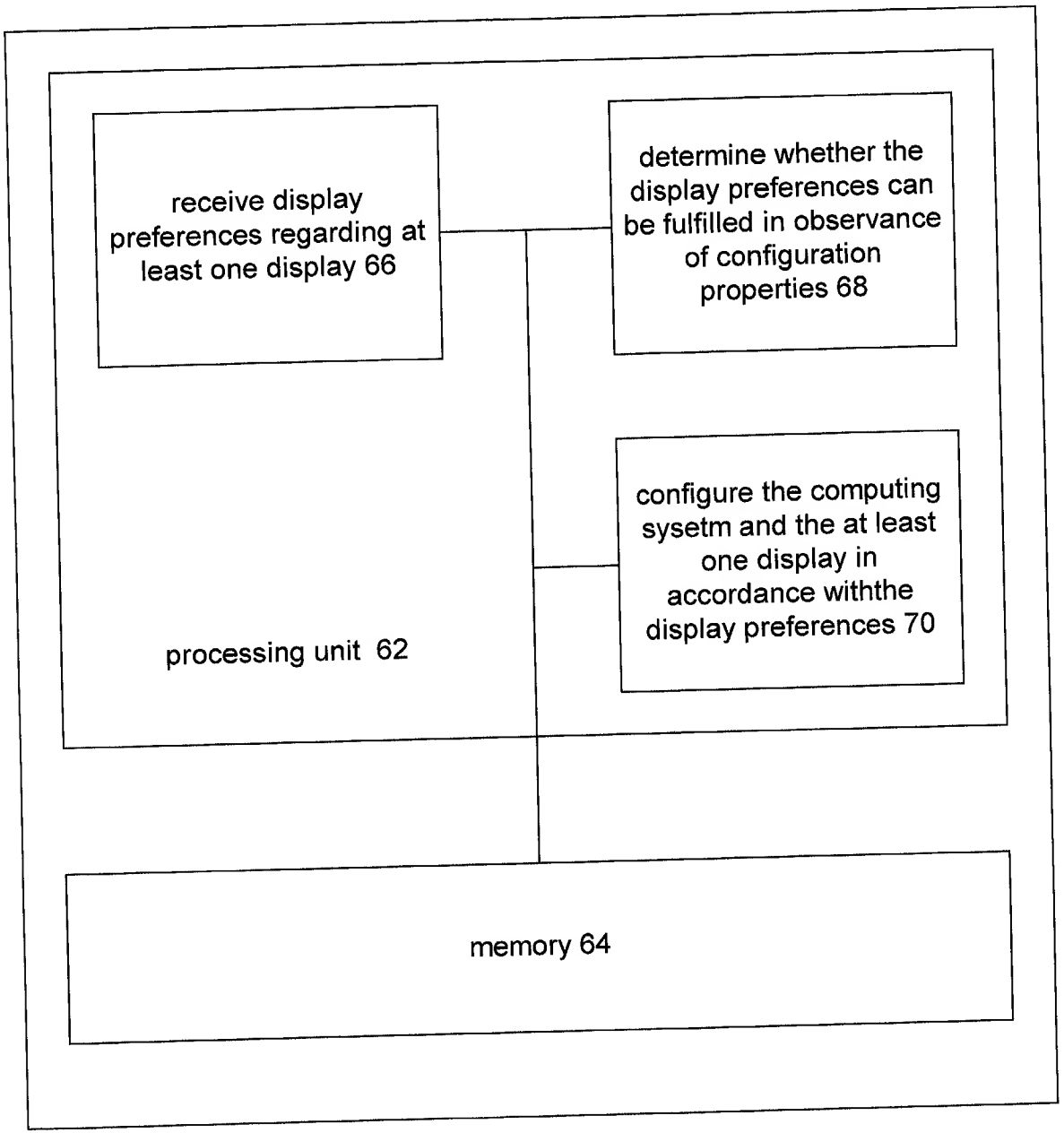
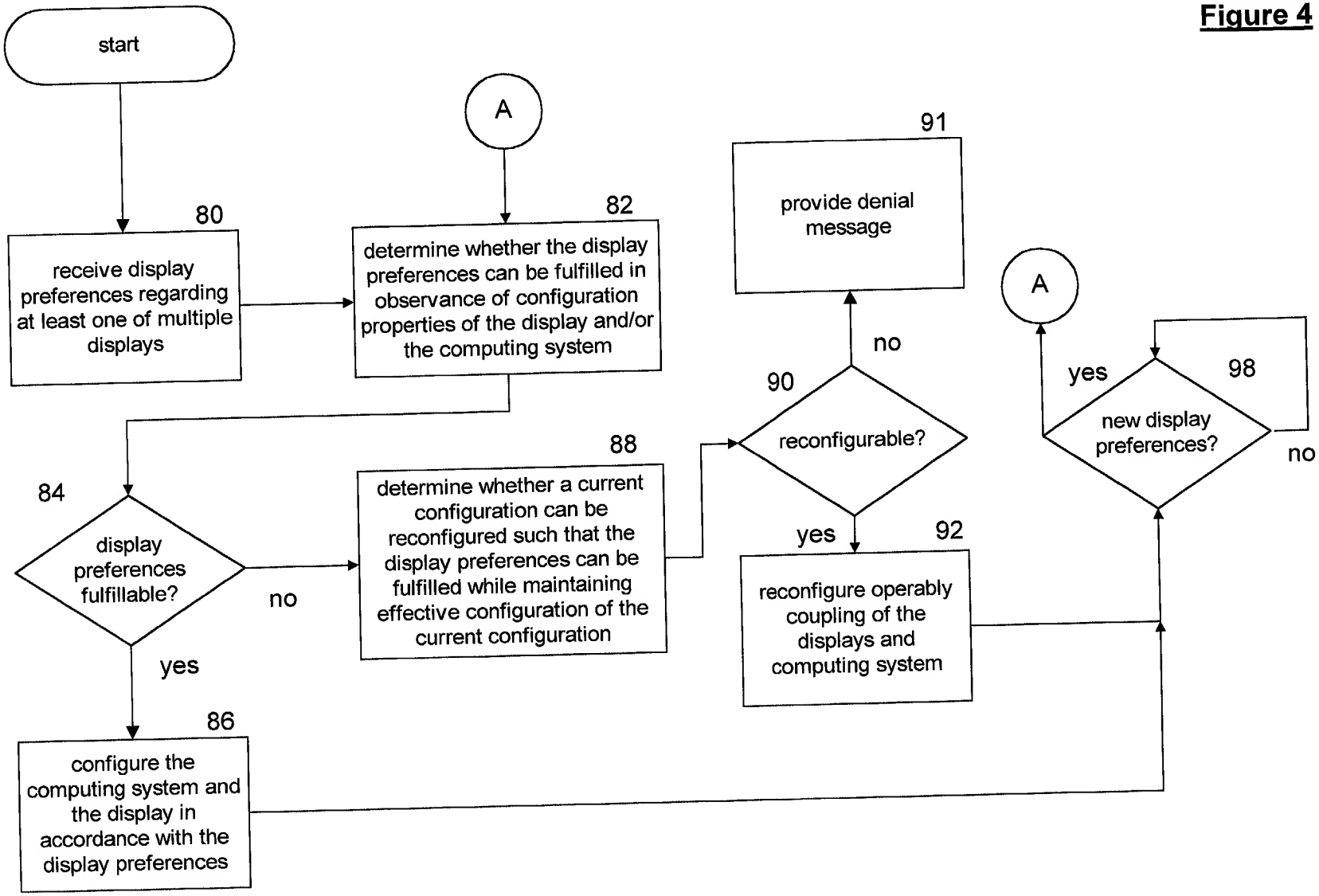

receive display preferences regarding at least one display 66
determine whether the display preferences can be fulfilled in observance of configuration properties 68
configure the computing sysetm and the at least one display in accordance withthe display preferences 70
processing unit 62
memory 64
video graphics processing circuit 60

Figure 3

Figure 4


start
A
80
receive display preferences regarding at least one of multiple displays
82
determine whether the display preferences can be fulfilled in observance of configuration properties of the display and/or the computing system
91
provide denial message
no
90
reconfigurable?
yes
92
reconfigure operably coupling of the displays and computing system
88
determine whether a current configuration can be reconfigured such that the display preferences can be fulfilled while maintaining effective configuration of the current configuration
84
display preferences fulfillable?
no
yes
86
configure the computing system and the display in accordance with the display preferences
A
yes
98
new display preferences?
no

OIPE JC60
SEP 0 8 1998
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PATENT APPLICATION
Docket No.: 0100-01117

DECLARATION AND POWER OF ATTORNEY
Pursuant to 37 C.F.R 1 63 and 1 67

As a below named inventor, we each hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am one of the original and first joint inventors of the subject matter of a patent application entitled: **METHOD AND APPARATUS FOR CONFIGURING MULTIPLE DISPLAYS ASSOCIATED WITH A COMPUTING SYSTEM**. The specification for the patent application (check one):

☐	is attached hereto.
☒	was filed on as Application Serial No 09/032,863 and was amended on (if applicable).
☐	was filed as PCT International Application No. PCT/ on and was amended on (if applicable).
☐	was filed on as Application Serial No. and was issued a Notice of Allowance on

I hereby state that I have reviewed and understood the contents of the above identified patent application, including the claims as amended by any amendment referred to above or as allowed as indicated above.

I acknowledge the duty to disclose all information known to me to be material to the patentability of this patent application as defined in 37 C.F.R. Section 1.56 for the pendency of the application. If this is a continuation-in-part (CIP) application, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability of the application as defined in 37 C.F.R. Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this CIP application

I hereby claim foreign priority benefits under 35 U.S.C. Sections 119 and 365 of any foreign application(s) for patent(s) or inventor's certificate(s) listed below. I have also identified below any foreign application(s) for patent(s) or inventor's certificate(s) filed by me or my assignee which:
disclose the subject matter claimed in this patent application; and
have a filing date that is either:
(1) before the filing date of the application on which my priority is claimed; or,
(2) before the filing date of this application when no priority is claimed:

Prior Foreign Patents

priority claimed	Number	Country	Mo/Day/Yr Filed	Date First Laid Open or Published	Date Granted or Patented
☐					
☐					
☐					

I hereby claim the benefit under 35 U.S.C. Sections 120 and 365 of any United States application(s) listed below and PCT international application(s) listed below:

Prior U.S. or PCT Applications

Application No.	Mo/Day/Yr Filed	Status

OIPE JC60
SEP 0 8 1998
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I hereby appoint Timothy W. Markison, Registration No. 33,534, Christopher J. Reckamp, Registration No 34,414, Paul Anderson, Patent Agent, Registration No. 39,896 all attorneys (or agents) with the firm of MARKISON & RECKAMP, P.C. having its principal place of business at 899 Skokie Boulevard- Suite 332, Northbrook Illinois 60062, and Sally Daub, Patent Agent, Registration No 41,478 of ATI Technologies, Inc. as my attorneys, with full power of substitution and revocation, to prosecute this patent application and to transact all business in the United States Patent and Trademark Office connected therewith, and to file and prosecute any international patent applications filed thereon before any international authorities under the Patent Cooperation Treaty, and I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct them in writing to the contrary.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this patent application or any patent issued thereon.

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